

## LIQUID FILLING METHOD AND APPARATUS

~~TECHNICAL FIELD~~

### RELATED APPLICATION DATA

**[0001]** This application is a §371 National Stage Application of PCT International Application No. PCT/JP2003/015866 filed December 11, 2003, the entire contents of which are incorporated herein by reference. This application also claims priority under 35 U.S.C. §119 and/or §365 to Japanese Application No. 2002-361443, filed December 12, 2002, the entire contents of which are incorporated herein by reference.

### FIELD OF THE DISCLOSURE

**[0002]** The present ~~invention~~disclosure relates to a method of filling a liquid and also relates to an apparatus for use in carrying out the method. More particularly, the present ~~invention~~disclosure relates to a liquid filling method and apparatus for uniformly filling a liquid containing a solid component into containers. The present ~~invention~~disclosure also pertains to a liquid filling method and apparatus capable of rapidly resuming the operation of a filling line after suspension while preventing deterioration of a filling liquid of high temperature.

~~BACKGROUND ART~~

### STATE OF THE ART

**COMPARISON DOCUMENT**

**[0003]** In the discussion of the state of the art that follows, reference is made to certain structures and/or methods. However, the following references should not be construed as an admission that these structures and/or methods constitute prior art. Applicant expressly reserves the right to demonstrate that such structures and/or methods do not qualify as prior art against the present invention.

**[0004]** In an ordinary beverage production line, the supply of a beverage from a beverage storage tank to a beverage filling machine (hereinafter referred to as simply "filler") is a flow in one direction. If the filler stops operating due to, for example, some problem with a bottle and becomes unable to accept the beverage, a sensor detects this situation and stops delivery of liquid to the filler. When the liquid delivery stops, the beverage in a filler bowl, i.e. a filler tank, cools naturally or is cooled with an aseptic air flow. Therefore, if the production line stops for more than a certain period of time, the liquid temperature becomes lower than the sterilizing temperature of containers, caps, etc. In this case, it is necessary, when resuming the operation of the filling line, to discard the cooled liquid in the filler tank and to blow the heated beverage (i.e. it is necessary to supply the heated beverage to the filler and to discharge it from filling nozzles) in order to raise the temperature of the filler tank and the filling nozzles. Accordingly, there are losses of beverage due to discard and blowing. To reduce these losses of beverage, some methods have been developed; for example, a method wherein when the filling line stops, the beverage in the filler is recovered and returned to the product tank in which the beverage is reheated before being

filled [Japanese Patent Unexamined Publication (KOKAI) No. 2001-72189], and a method wherein the beverage in the filler is reheated and circulated [Japanese Patent Unexamined Publication (KOKAI) No. 2002-337988]. However, the former method cannot prevent lowering of the temperature of the filler and needs blowing of the heated beverage in order to heat the filler and the nozzles when resuming the operation. Accordingly, the method suffers a loss of beverage due to the blowing process. The latter method always keeps the beverage in the filler at high temperature and hence allows the operation to be resumed immediately after the problem has been eliminated. On the other hand, because the liquid in the filler is kept at high temperature at all times, the beverage may deteriorate in aroma and taste, depending on the kind of beverage.

**[0005]** There has also been developed a system in which a liquid is constantly circulated through a filling line including a product storage tank, a heat sterilizer, and filling valves [Japanese Patent Unexamined Publication (KOKAI) No. Sho 59-74097]. In this system, the liquid is kept at high temperature while it is refluxed from the filling valves to the product storage tank. Therefore, the aroma and taste of products degrade. In addition, because the liquid of high temperature is refluxed into the product storage tank, the storage tank temperature becomes nonuniform, causing the heat sterilization process to become unstable. Further, a system has been developed in which when the filling operation stops, the heated beverage is allowed to circulate by bypassing through a part of the filling line, excluding the filler (i.e. so-called divert circulation; Japanese Patent Post-Exam Publication

No. Hei 2-27236). In this case, the temperature of the beverage in the filler lowers. Therefore, it is necessary to perform blowing to raise the temperature of the filler. Accordingly, there has been a demand for development of a method capable of preventing lowering of the temperature of the beverage in the filler and allowing filling to be started immediately upon resumption of the filling line operation, and also capable of preventing deterioration of aroma and taste of the beverage.

**[0006]** Meanwhile, when filling a beverage containing a solid component, it is difficult to keep the solid component content of the filling liquid constant. Therefore, in one type of filling method, the solid component and the liquid are filled separately from each other. In this case, however, the apparatus becomes large in size and high in cost, and it is difficult to add the apparatus to existing equipment. Accordingly, there has been developed an apparatus in which an additional line is provided to allow the beverage in the filler to circulate through a path in the neighborhood of the filler [Japanese Patent Unexamined Publication (KOKAI) No. Hei 6-293302]. However, even if the solid component content is kept constant by circulating the beverage in the neighborhood of the filler, if the solid component content of the beverage becomes nonuniform at another part of the filling line, it becomes impossible to perform uniform filling. Therefore, there has also been a demand for a method capable of maintaining uniform conditions throughout the production line.

**[0007]** When the filling process is suspended for any reason, the flow of liquid in and out of the filler stops, and the rotating motion of the filler also

stops. Consequently, the beverage in the filler stops flowing. If there is no flow of beverage in the filler, the solid component contained in the beverage settles by gravity or surfaces, resulting in separation of the solid component and the liquid. If the filling process is resumed in this state, the solid component content changes as follows. For example, at the beginning of the resumed filling process, the solid component content is high because it has settled. Thereafter, the solid component content becomes extremely low, and as time goes by, it returns to normal and becomes uniform. In this case, the solid component content varies among products undesirably. Accordingly, it has been demanded to develop a method capable of filling with a constant solid component content when the operation of the production line is resumed after suspension.

#### ~~SUMMARY OF THE INVENTION~~

**[0008]** The present invention was made in view of the above-described problems with the conventional liquid filling method. An object of the present invention is to provide a liquid filling method and apparatus which is capable of reducing the lead time when the filling operation is resumed, as well as being capable of suppressing the deterioration of aroma and taste of the filling liquid.

**[0009]** Another object of the present invention is to provide a liquid filling method and apparatus capable of keeping the solid component content constant when filling a liquid containing a solid component.

**[0010]** A further object of the present invention is to provide a liquid filling method and apparatus capable of preventing lowering of the temperature of a

high-temperature liquid to be filled, thereby reducing the lead time when the filling operation is resumed, and achieving energy saving.

**[0011]** A still further object of the present invention is to provide a liquid filling method and apparatus having a circulation path capable of minimizing the filling liquid loss when filling a liquid of high temperature.

**[0012]** According to the present invention, there is provided a liquid filling method wherein a liquid is delivered from a storage tank into a filler tank of a filler, and the liquid is filled into containers by the filler. The liquid filling method is characterized in that the liquid in said filler tank is returned through a return piping attached to said filler tank and refluxed to said storage tank through a reflux path so that the liquid circulates throughout the entire filling line extending from said storage tank to said filler. According to the present invention, there is provided a liquid filling apparatus that fills a liquid into containers. The apparatus includes a liquid filling line having a storage tank that stores the liquid and a filler that fills said liquid into the containers, wherein the liquid in a filler tank is returned through a return piping attached to the filler tank to the entire liquid filling line so that said liquid constantly circulates throughout said liquid filling line.

**[0013]** According to the present invention, an excess of liquid in the filler tank can be circulated throughout the filling line. Consequently, the liquid can constantly circulate through the line. Therefore, it is possible to suppress lowering of the temperature of the liquid in the filler tank even during suspension of the operation of the line and hence possible to resume production after the suspension of the line operation substantially without lead

time. In filling of a liquid containing a solid component, uniform conditions can be maintained throughout the production line. Therefore, it is possible to produce products with no variations in the solid component content, regardless of whether the filling temperature is normal or low.

**[0014]** In addition, according to the present invention there is provided a liquid filling method wherein a liquid delivered from a storage tank is heat-sterilized before being delivered into a filler tank of a filler, and the liquid is filled into containers by the filler. The liquid filling method is characterized in that the liquid in said filler tank is returned through a return piping attached to said filler tank and refluxed to said storage tank through a reflux path so that the liquid circulates throughout the entire filling line extending from said storage tank to said filler, wherein the liquid flowing through said reflux path to said storage tank is cooled. According to the present invention there is provided a liquid filling apparatus that fills a liquid into containers. The liquid filling apparatus includes a liquid filling line having a storage tank that stores the liquid, a heat sterilizer that heat-sterilizes said liquid, and a filler that fills said liquid into the containers, wherein the liquid in a filler tank is returned through return piping attached to said filler tank to the entire liquid filling line so that said liquid circulates throughout said liquid filling line, said apparatus further including a cooling device that cools the liquid flowing through said reflux path.

**[0015]** According to the above-described method and apparatus of the present invention, a part of liquid in the filler tank is constantly refluxed to the storage tank through the reflux path, and the liquid flowing through the reflux

path is cooled by a cooling process using a cooling device. By this process, the liquid left unused for filling can be circulated throughout the liquid filling line, regardless of whether filling is being performed or not, and the filler temperature can be always kept at high level. Moreover, the uniformity of the liquid in the line can be guaranteed. Provision of the process for cooling the liquid before it is refluxed to the storage tank prevents quality deterioration of the liquid, which might otherwise occur when the liquid is kept at high temperature for a long period of time. It is also possible to keep the storage tank temperature constant and to stabilize the heat sterilization process.

**[0016]** The above-described liquid filling method may be as follows. The amount of liquid in the filler tank is detected by means of a detecting device, and at least one of the amount of liquid supplied to the filler tank and the amount of liquid returned from the filler tank is controlled according to a detected value from the detecting device. In this case, the liquid quantity may be controlled as follows. During filling by the filler, the amount of liquid supplied to the filler tank may be larger than the amount of liquid returned from the filler tank. During suspension of filling, the amount of liquid supplied to the filler tank may be equal to the amount of liquid returned from the filler tank.

**[0017]** The liquid filling apparatus may have a detecting device that detects the amount of liquid in the filler tank, and a controller that controls at least one of the amount of liquid supplied to the filler tank and the amount of liquid returned from the filler tank according to a detected value from the detecting device. In this case, the liquid quantity may be controlled as follows. During filling by the filler, the amount of liquid supplied to the filler tank may be larger

than the amount of liquid returned from the filler tank. During suspension of filling, the amount of liquid supplied to the filler tank may be equal to the amount of liquid returned from the filler tank.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The following detailed description of preferred embodiments can be read in connection with the accompanying drawings in which like numerals designate like elements and in which:

~~Fig~~[0019] FIG. 1 is a schematic general view of a liquid filling apparatus for carrying out the invention of this application.

~~Fig~~[0020] FIG. 2 is a plan view of a filler.

~~Fig~~[0021] FIG. 3 is an enlarged view of a part of ~~Fig~~FIG. 2, showing an inlet opening and a return opening in the filler.

~~Fig~~[0022] FIG. 4 is a schematic sectional view of a filler tank equipped with stirring members.

~~Fig~~[0023] FIG. 5 is a schematic general view showing another embodiment of the liquid filling apparatus according to the invention of this application.

~~Fig~~[0024] FIG. 6 is a diagram showing supply and return pipes attached to a filler tank of the liquid filling apparatus shown in ~~Fig~~FIG. 5.

~~BEST MODE FOR CARRYING OUT THE INVENTION:~~

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

**[0025]** Embodiments of the present invention will be described below with reference to the accompanying drawings and with regard to a beverage filling apparatus that fills a beverage as a filling liquid.

~~Fig~~**[0026]** FIG. 1 shows an example of the general arrangement of a liquid filling apparatus used to carry out the invention of this application. A beverage stored in a beverage tank 5 is delivered through a liquid delivery pump 6 provided in a supply line 14 to a heat sterilizer 7 in which the beverage is heat-sterilized. The temperature of heat sterilization differs according to the kind of beverage. For example, tea is heat-sterilized at a temperature of about 140°C. A beverage containing fruit flesh is heat-sterilized at a temperature of around 90°C. This process is unnecessary in the case of normal or low-temperature filling. The heat-sterilized beverage is cooled by a cooling device 8 to a temperature suitable for filling, e.g. to a temperature of about 82°C to 87°C if containers for filling are PET (polyethylene terephthalate) bottles. This process may be omitted in the case of normal or low-temperature filling. The cooled liquid is deaerated, for example, in a deaeration tank 9. This is done for the purpose of preventing foaming and also preventing quality degradation due to oxidation. The deaeration process may be omitted in the case of normal or low-temperature filling.

**[0027]** Next, the beverage is delivered in the direction of the arrow A through a pump 10 serving as a delivery device and introduced into a filler tank 4 of a filler 1. During a filling operation, the beverage is filled into containers, e.g., PET bottles, by the filler 1 having a publicly known structure. At this time, the liquid level in the filler tank 4 is monitored by means of a level

meter. If overflow occurs, the beverage is recovered through return pipes 3 and delivered by a discharge pump 11 provided in a return line 15 in the direction of the arrow B to a cooling device 12 in which the beverage is cooled down to approximately normal temperature. The cooled beverage returns to the beverage tank 5.

**[0028]** By circulating as stated above, the beverage continuously flows through the line and is stirred effectively so that the solid component will not settle or surface. Accordingly, uniform filling can be performed. In addition, the solid component content of the beverage will not vary when the filling process is resumed after suspension of the operation of the line. Further, because lowering of the filler temperature can be prevented, it is possible to rapidly resume the filling process after suspension of the line operation. It is also possible to reduce waste loss due to blowing of beverage (discharge from the filler). Further, because the return liquid is cooled, it is possible to prevent quality degradation that might otherwise occur when the beverage is constantly exposed to high temperature. In addition, it is possible to keep the temperature of the beverage tank 5 substantially constant and hence it is possible to stabilize the subsequent process of heat sterilization. The cooling process may be omitted in the case of normal or low-temperature filling.

**[0029]** In order to reflux the beverage from the filler, the filler tank is provided with return pipes. Each return pipe is connected to the filler tank by welding or by a publicly known method in a leak-free state with a packing or the like interposed therebetween. The number of return pipes is typically about 2 to 4 but may be larger than that. If a double pipe is used for a

combination of a supply pipe and a return pipe, piping can be formed from a single system of pipes and thus simplified. In such a case, the feed liquid and the return liquid, which are at high temperature, are adjacent to each other across the pipe wall and hence capable of effectively keeping each other warm. As shown in ~~Figs~~FIGS. 2 and 3, supply pipes 2 are opened in a direction opposite to the direction of rotation of the filler 1 to cause turbulence in the flow of liquid in the filler 1, thereby enabling the stirring effect to be enhanced. The return pipes 3 may be opened perpendicularly to the circumferential direction as shown in ~~Figs~~FIGS. 2 and 3. Alternatively, the return pipes 3 may be opened at a certain angle to the circumferential direction to cause turbulence in the flow of beverage. The return pipes 3 may also be opened in the same direction as the beverage flow direction so as not to produce a turbulent flow. It is preferable that the opening of each return pipe 3 be provided at a position where the liquid is uniform in view of the properties of the beverage; for example, in the vicinity of the inlet opening of a supply pipe 2 from which the liquid flows into the filler 1. In a case where stirring members are additionally provided, the opening of each return pipe 3 is preferably provided in the neighborhood of a stirring member.

**[0030]** In the present invention, the liquid is constantly circulated and thus stirred in the filler tank. If stirring members are used, the liquid can be stirred even more efficiently. Particularly, when the filling operation by the filler stops, although the liquid is continuously circulated, stirring may become insufficient because the turning of the filler and the filling operation are suspended. In such a case, the use of stirring members makes it possible to push down a

solid component that is likely to surface and to allow a readily settling component to rise up. Therefore, a liquid containing a solid component can be kept more uniform. In this case, stirring members capable of pushing down or up in the liquid may be used. For example, as shown in ~~Fig~~FIG. 4, stirring members 13 each have a parallelepiped configuration with a thickness of 2 mm to 5 mm and a width sufficient for the stirring member 13 to cross the inside of the filler tank horizontally so that the stirring member 13 can be secured at one lateral end thereof to the outer surface of the inner periphery of the filler tank and at the other lateral end thereof to the inner surface of the outer periphery of the filler tank. The length of the stirring member 13 is, for example, about 70% of the depth from the liquid surface. The stirring member 13 has an angle of about 20 to 40 degrees with respect to the horizontal plane. The configuration of the stirring members is not necessarily limited to being rectangular parallelepiped. For example, it is also possible to use stirring members having a streamline, elliptic or oval shape, a triangular prism shape, or a quadrangular prism shape with a trapezoid section. It should be noted, however, that the configuration of the stirring members is not necessarily limited to these. It is essential only that the stirring members should be capable of pushing down or up in the liquid. The use of such stirring members allows a liquid containing a solid component to be kept even more uniform when it is circulated throughout the path. Hence, it is possible to rapidly resume the filling operation after suspension of the filler.

~~Fig~~[0031] FIG. 5 schematically shows the general arrangement of a liquid filling apparatus having a circulation path according to another embodiment of

the present invention. In this embodiment, constituent elements that are substantially the same as those shown in the foregoing embodiment are denoted by the same reference numerals with a suffix "a" added. A liquid filled by this filling apparatus is prepared in a preparation tank (not shown) and delivered to a cushion tank 5a where it is stored. It should be noted that in this embodiment a high-temperature liquid is filled, but the liquid as supplied to the cushion tank 5a is at normal temperature.

**[0032]** The liquid stored in the cushion tank 5a is supplied to a filling liquid tank, i.e. a filler tank 4a, of a filler 1a through a supply line 14a by the operation of a supply pump 10a serving as a liquid supply device. The supply line 14a is provided with a heater (heat exchanger) 7a as a heating device. The liquid from the cushion tank 5a is heated to a predetermined temperature for sterilization by the heater 7a. After being sterilized in this way, the liquid is delivered to the filler tank 4a. It should be noted that in this embodiment the supply pump 10a constantly delivers a fixed amount of liquid.

**[0033]** The supply line 14a is connected to the filler tank 4a of the filler 1a through a rotary joint 16a. As shown in ~~Fig~~FIG. 6, the filler tank 4a has an annular configuration. The supply line 14a is connected to the filler tank 4a through a plurality (3 in this embodiment) of circumferentially equally spaced supply pipes 2a.

**[0034]** The filler tank 4a is further connected with a return line 15a through a plurality (3 in this embodiment) of return pipes 3a in the same way as the supply line 14a. The supply pipes 2a of the supply line 14a and the return pipes 3a of the return line 15a are equally spaced. The supply and return

pipes 2a and 3a are arranged alternately in the circumferential direction. The return line 15a connects between the filler tank 4a of the filler 1a and the cushion tank 5a through the rotary joint 16a. The cushion tank 5a, the supply line 14a, the filler tank 4a and the return line 15a form in combination a circulation path. The return line 15a is provided with a discharge pump 11a serving as a device that returns the liquid from the filler tank 4a to the cushion tank 5a. The return line 15a is further provided with a cooler (heat exchanger) 12a. By the operation of the discharge pump 11a, the liquid in the filler tank 4a is delivered to the cooler 12a where it is cooled before being returned to the cushion tank 5a. It should be noted that in this embodiment the amount of liquid delivered by the discharge pump 11a can be controlled. The amount of liquid delivered is controlled according to a signal from a level sensor 22a (described later).

**[0035]** The filler tank 4a of the filler 1a has a plurality of filling devices (filling valves) 17a provided on the outer periphery thereof at equal spacings in the circumferential direction. The filling liquid supplied into the filler tank 4a through the supply line 14a is filled into containers (not shown) through the filling valves 17a.

**[0036]** The filler tank 4a is provided with a level sensor 22a to detect the amount of liquid in the filler tank 4a. A detection signal from the level sensor 22a is transmitted to a controller 23a. A command from the controller 23a controls the amount of liquid delivered by the discharge pump 11a.

**[0037]** The operation of the filling system arranged as stated above will be described below. A liquid to be filled into containers is prepared in a

preparation tank (not shown) and delivered into the cushion tank 5a where it is stored. At this time, the liquid is at normal temperature. The liquid in the cushion tank 5a is delivered to the heater 7a by the drive of the supply pump 10a. After being heated to a predetermined temperature and thus sterilized in the heater 7a, the liquid is supplied to the filler tank 4a of the filler 1a. The level sensor 22a provided in the filler tank 4a constantly detects the amount of filling liquid in the filler tank 4a. The controller 23a controls the amount of liquid delivered by the discharge pump 11a according to the value of liquid quantity detected by the level sensor 22a.

**[0038]** During normal operation, the liquid supplied into the filler tank 4a is filled into containers through the filling valves 17a, and a larger amount of liquid than is needed for filling is supplied to the filler tank 4a. Meanwhile, the filling liquid in the filler tank 4a is returned to the cushion tank 5a through the cooler 12a by the operation of the discharge pump 11a. As shown in ~~Fig~~FIG. 5, the filling liquid from the cushion tank 5a constantly circulates through the supply line 14a, the heater 7a, the supply pump 10a, the supply pipes 2a, the filler tank 4a, the return pipes 3a, the discharge pump 11a, the cooler 12a and the return line 15a. In this embodiment, the supply pump 10a constantly supplies a fixed amount of liquid to the filler tank 4a, whereas the discharge pump 11a returns a fixed amount of filling liquid to the cushion tank 5a according to the amount of liquid filled from the filling valves 17a.

**[0039]** During suspension of the operation of the filler 1a, filling from the filling valves 17a into containers is not carried out. Therefore, if the same amount of filling liquid as during normal operation is discharged from the filler

tank 4a, the amount of liquid in the filler tank 4a will gradually increase. In this embodiment, however, the amount of liquid discharged from the filler tank 4a is increased by controlling the discharge pump 11a according to the value of liquid quantity detected by the level sensor 22a, thereby adjusting the amount of liquid in the filler tank 4a. More specifically, if the detected value from the level sensor 22a exceeds a predetermined upper limit, the controller 23a judges that the filler 1a has stopped operating, and controls the discharge pump 11a so that the same amount of filling liquid as supplied from the supply pump 10a is returned from the filler tank 4a. For example, let us assume that during normal operation, the liquid is supplied from the supply pump 10a at a rate of  $250 \pm 1$ /m, and the liquid is filled into containers at a rate of  $200 \pm 1$ /m, and that the liquid is returned to the cushion tank 5a at a rate of  $50 \pm 1$ /m by the discharge pump 11a. On this assumption, if the filler 1a stops operating, no liquid is filled into containers. Therefore, the capacity of the discharge pump 11a is increased so that the liquid is returned to the cushion tank 5a at a rate of  $250 \pm 1$ /m that is the same as the rate ( $250 \pm 1$ /m) of supply from the supply pump 10a. It should be noted that when the filler 1a stops operating, the capacity of the supply pump 10a may be reduced so that the supply pump 10a supplies the liquid at a rate of  $50 \pm 1$ /m that is the same as the rate ( $50 \pm 1$ /m) at which the liquid is returned by the discharge pump 11a. The control may be effected such that the capacity of the supply pump 10a is reduced to  $100 \pm 1$ /m, whereas the capacity of the discharge pump 11a is increased to  $100 \pm 1$ /m.

**[0040]** The filling liquid refluxed from the filler tank 4a is cooled through the cooler 12a before being returned to the cushion tank 5a. In the case of filling a high-temperature liquid, if the liquid refluxed from the filler tank 4a is returned to the cushion tank 5a as it is, the temperature in the cushion tank 5a rises undesirably. Consequently, when the liquid from the cushion tank 5a is thereafter supplied through the heater 7a, the liquid temperature undesirably further rises in excess of a set temperature. Therefore, the liquid refluxed from the cushion tank 5a is cooled by the cooler 12a to a temperature substantially equal to the temperature of the liquid stored in the cushion tank 5a.

**[0041]** Accordingly, the amount of liquid that has to be blown when the operation is resumed is extremely small (it is only necessary to blow a very small amount of liquid remaining in the passage extending from the filler tank 4a to the filling valves 17a). Thus, the loss of filling liquid can be minimized. Although in this embodiment the discharge pump 11a is controlled to adjust the amount of liquid returned from the filler tank 4a, it should be noted that the adjustment of the amount of liquid returned is not necessarily limited to that effected by controlling the discharge pump 11a, but may be made, for example, by using a control valve additionally provided. It is also possible to control the amount of liquid delivered from the supply pump 10a on the supply side.

~~ADVANTAGEOUS EFFECTS OF THE INVENTION:-~~  
Advantageous Effects of the Invention:

**[0042]** The present invention offers the following advantageous effects.

(a) Even when the filling operation of the filler stops, because the beverage is constantly circulated, the beverage in the filler is stirred. Accordingly, the uniformity of the beverage is maintained throughout the filling line.

(b) A solid component will not settle or surface, and it is possible to keep the solid component content constant when filling a beverage containing a solid component.

(c) Because the liquid is circulated throughout the entire filling line, the temperature of the filler tank and that of the beverage in the filler tank can be prevented from lowering.

(d) The circulation allows the liquid in the filler tank to flow constantly and hence makes it possible to prevent adhesion of the pulp content to the inner surface of the filler tank. Further, because the liquid circulates, it is possible to increase the velocity of washing flow in the filler tank upon completion of the filling operation and hence it is possible to improve the capability to wash away the pulp content.

(e) Because the return liquid is cooled, it is possible to prevent quality degradation that might otherwise occur when the beverage is constantly exposed to high temperature.

(f) When a beverage containing a solid component is filled at high temperature, lowering of the filler temperature can be prevented by circulation of the beverage throughout the entire circulation path extending from the storage tank to the filler. At the same time, stirring induced by the circulation

causes mixing of the solid component with the liquid component. Thus, the filling operation can be started rapidly upon resumption of the operation of the filling line.

(g) The circulation eliminates stagnation of a beverage liquid. Consequently, the path from the heater through the filler to a point immediately upstream of the cooler is always kept at high temperature. Thus, it is possible to prevent propagation of microorganisms in this part of the path.

(h) Even in normal or low-temperature filling of a beverage containing a solid component, the solid component and the liquid component are always mixed together by the circulation of the beverage throughout the entire filling line extending from the storage tank to the filler. Therefore, there will occur no separation between the solid component and the liquid components in the filler or the piping. Stirring taking place throughout the path from the storage tank to the filler allows the beverage to be stirred even more uniformly than stirring performed only around the filler as in the conventional technique. Accordingly, the uniformity of products is further improved.

(i) The amount of liquid in the filler tank is detected by means of a detecting device, and at least one of the amount of liquid supplied to the filler tank and the amount of liquid returned from the filler tank is controlled by means of a controller according to a detected value from the detecting device. Accordingly, it is possible to minimize the amount of liquid that has to be blown in the heat-up process when the filling operation is resumed.

[0043] Although the present invention has been described in connection with preferred embodiments thereof, it will be appreciated by those skilled in the art

that additions, deletions, modifications, and substitutions not specifically  
described may be made without department from the spirit and scope of the  
invention as defined in the appended claims.